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ABSTRACT

This report presents the procedure, results and conclusions of a study designed to test the hypothesis that there would be no difference in the number of acceptable laboratory reports submitted by students in a ninth-grade science course under a schedule of continuous reinforcement where the teacher graded every report, as compared to the number submitted under a 25 percent variable-ratio partial reinforcement schedule where the teacher graded only one out of every four reports submitted by students. A 2 x 2 quasi-experimental design was used with two groups of 48 students during an 18 week period. Results indicated no significant differences between the two groups. Several limitations in interpretations of the results and the implications of the findings for classroom procedures were discussed. Bibliography. (LC)

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EVALUATION OF STUDENT LABORATORY REPORTS UNDER A SCHEDULE OF PARTIAL REINFORCEMENT*

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Previous research findings agree that fewer responses may be required under a partial reinforcement (PR) schedule to maintain a level of performance approaching or equaling a continuous reinforcement (CR) schedule.[1, 2] Although extensive research has been directed at studying the effects of various reinforcement schedules on the behavior of living organisms, most previous studies have been concerned with the effects of PR on animal behavior.[3,4,5,6]

In comparison to research on animal behavior, the literature shows few investigations dealing with the effects of PR on human subjects. Several psychologists cautioned against a broad generalization of reinforcement principles derived originally from animal research and extending them to classroom applications,[7,8,9,] but an equally prominent portion of the literature cited the outstanding potential existing in the principles of PR for classroom

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teachers.[10, 11, 12] Ages of students used in PR studies were principally pre-school, primary, or college level. No research findings reported the effects of PR schedules on the complex learning behavior of secondary school students.[13]

Provocative prescriptions for applying PR schedules to classroom learning tasks were made by several educational psychologists, but few specific recommendations could be utilized in the classroom,[14, 15, 16, 17, 18, 19, 20] and only two supported their views with experimental designs which could be empirically tested.[21, 22] With few exceptions, empirical research of the effects of PR schedules on human behavior limited their subjects' responses to (1) short verbal expectations, (2) "yes" or "no" replies, or (3) operant or instumental responses, i.e., lever pulling or button pushing.[23, 24, 25, 26, 27] Results of these studies conclusively demonstrated that PR schedules affect human responses in simple learning tasks.

Consequently, this study was designed to apply a PR schedule for a complex learning task in an actual classroom environment; and test the null hypothesis that there would be no difference in the number of acceptable laboratory reports submitted by students in a ninth-grade science course under a schedule of CR where the teacher graded every report, as compared to the number submitted under a 25% variable-ratio PR schedule where the teacher graded only one out of every four laboratory reports submitted by students.

Method

Subjects

48 students enrolled in two ninth-grade science classes in a suburban southern California junior high school were the sample for this study. The ninth-grade science program was an elective course whose requirements were a grade of "A", "B", or "C" with a teacher's written permission in the previous required eighth-grade science course. As a result, it was believed that the students were either (1) highly science-oriented in comparison to the other 356 students of the ninth-grade who did not elect the course, or (2) were in the program because of parental pressure or peer group status. In either case, it was beyond the scope of this study to investigate why the students enrolled in the course.

Design

Acquisition period. Students of both classes were trained for ten weeks in the writing of acceptable laboratory reports, under a CR schedule. Each written assignment was graded and returned to the student before beginning the next report. If the student turned in a written laboratory report that was not acceptable to the teacher, it was returned. If the student wished to receive credit for the unacceptable work, he was asked to revise the laboratory report and return the assignment on the following

day. This acquisition or training period included eight reports, and comprised approximately 50% of the student's grade for the ten week period.

Data were recorded on the number of acceptable laboratory report responses turned in by each student. Students were divided into two categories in terms of recording data for the reinforcement schedules to follow: (1) those students who displayed 100% response in the acquisition period, and (2) less than 100% response. A counter-balanced 2 x 2 quasi-experimental design[28] was used for the treatment phases. Independent variables were the schedules of reinforcement (25% and 100%), and the dependent variable was the number of acceptable laboratory report responses turned in by the students of both groups.

Phase I: Group A (CR)/Group B (PR). One science class (Group A, N = 25) was given CR for four more laboratory reports over a period of four weeks, and was the control group for Phase I. Group A students were not told of the activities of the experimental group, although it was expected that they would learn about them from students of the other science class. The experimental group students (Group B, N = 23) were given a 25% variable - ratio PR schedule for the same four laboratory reports during the same four week period.

It was explained to the experimental group that only one out of four of the next four laboratory reports was to be graded, selection of which was to be done by a random choice method. The

numerical value or grade received on the paper was to be multiplied by four and reported to the students. It was explained that the randomly selected laboratory report carried the same weight as all four of the reports in terms of the final semester grade. A rationale and justification of the procedure was given to the experimental group, but no mention was made of the fact that this was part of a research study. A careful explanation of the gambling factor involved for the student if he did not turn in a laboratory report and the consequent penalty to his final grade was outlined.

The students were given one weeks notice regarding the due date for each laboratory report. If a student failed to turn in a report on the due date, an additional day was allowed with a 10% penalty subtracted from his grade. Each student was aware of the fact that he would be penalized by having the teacher subtract 10% (x 4), if this late report was selected for grading purposes.

After the four experiments were turned in, the teacher selected the report to be graded by placing four numbered slips of paper in a box, and having a student draw one of the numbered slips of paper. The students were immediately informed as to which experiment would be graded, and all the laboratory reports, graded and ungraded, were returned to the students on the following day. If a student was absent for that particular experiment, the teacher randomly selected a report from the remaining three for grading purposes.

Phase 2: Group A (PR)/Group B (CR). After the four laboratory reports were returned, Group B was informed that they were going to be placed on a CR schedule, and that each laboratory report turned in would be graded and returned immediately. No reason was given for this change in the grading method except to say that the teacher had been "trying out the previous method, and wanted to see what would happen." Group B became the control group for Phase 2. At the same time, Group A, heretofore the control group, became the experimental group for Phase 2. Group A submitted to the same 25% variable-ratio PR schedule outlined above.

Results

During the acquisition period of CR for both Groups A and B, out of 48 students, 35 students submitted 100% acceptable responses for the eight laboratory reports (Group A, 18 students with 100% response out of 25; Group B, 17 out of 23.)

In Phase 1, students who showed 100% response during the acquisition period displayed 100% response regardless of whether they were given CR or PR ($\underline{X}^2 = 0.0000$, $\underline{p}. \not< 1.00$). Students who had less than 100% response during the acquisition period showed no significant differences during Phase 1, regardless of the type of reinforcement administered ($\underline{X}^2 = 0.0914$, $\underline{p}. \not< .80$). Table I summarizes the students responses under the two schedules of reinforcement.

Insert Table I about here

Again, during Phase 2, there were no significant differences between the number of responses shown by students of Group A and B displaying 100% response during the acquisition period ($\underline{X}^2$=0.0061, p. $\angle$.95), and students of Groups A and B displaying less than 100% response during acquisition ($\underline{X}^2$=0.0163, p. $\angle$.90).

In summarizing the chi squared values computed from Phases 1 and 2, there were no significant differences in the students responses under a CR schedule as compared to a 25% variable-ratio PR schedule ($\underline{X}^2$=0.1138, 4 d.f., p. $\angle$.995).

Discussion

Support for the experimental hypothesis is inferred, since the null hypothesis may not be rejected using a chi squared 2 x 2 fold contingency test with Yates' correction for continuity. Results of this study agree with previous empirical findings related to PR in that the same level of performance may be maintained by a PR schedule as compared to a CR schedule. However, no previous research described the application of a PR schedule to a complex learning task in an actual secondary school classroom situation.

There are several limitations to be considered in interpreting the results of this investigation. First, students were not randomly selected, and were chosen on the basis of availability to the teacher. Students were above average in intelligence and interest as indicated by the fact that the ninth-grade classes selected for

this study were an elective course, with a prerequisite grade of "A", "B", or special permission, in the preceding required eighth-grade science course. Second, the effects of the 25% variable-ratio PR schedule were only studied with four experiments for each group during a ten week period. The inference that similar results would occur for the same group during an entire semester or academic school year is unwarranted from the data. Third, interpretation of the data is also limited by the fact that no provision was made to control for the "quality" of the students' laboratory reports during the investigation, although standards of "acceptability" were held constant during the acquisition period and experimental phases since they were administered by the same teacher.

Finally, in terms of S-R theory, this situation was one where each time the student submitted a written report (response), the teacher evaluated the paper and returned it with some explanatory comments and a grade (reinforcement). This is an oversimplified model of the classroom environment, since the student's reward was probably more complex in nature. In terms of the student, all or any of the following may have constituted a reward: acceptance of the report, verbal approval or affirmation upon acceptance of the report, the teacher's operant act of collecting the report, or the student's satisfaction or relief upon completing the assigned task. Also, interpretation may follow drive-reduction theory[29] where the reward resulted from: the student not being penalized,

the teacher not entering a "zero" in his gradebook, the absence of a verbal reprimand, the student's avoidance of a feeling of guilt for not turning in the report, or the avoidance of peer disapproval, assuming the students were highly motivated. Other possible interpretations of reward may be cited, but this investigator is aware of the limitation in defining reward as simply being the grade indicated on an acceptable laboratory report.

Despite these limitations, one important conclusion for actual classroom practice may be inferred from the results of this study: it appears feasible that once a level of acquisition has been achieved, it is not necessary for a teacher to grade every report submitted by his students in order to maintain the same level of response.

There are also several implications in terms of classroom procedures and possible areas for further study:

Classroom Procedures

1. The teacher can give an optimum number of written assignments without creating an overburdening task of evaluation.

2. The teacher can spend more time on developing other aspects of his curriculum and instruction.

3. The students can obtain a critical evaluation on the work graded (albeit one out of four reports).

4. The students can obtain more practice in preparing and writing reports.

5. The students can be exposed to a grading situation which bears a closer similarity to the work environment they will encounter after their formal education.

Areas for Further Study

1. Maintaining the 25% PR schedule to study its effects over a longer period of time.

2. Testing of the student responses under a schedule of non-reinforcement or extinction. This would be a test of previous research findings that students under a PR schedule show more resistance to a schedule of extinction than those trained under a CR schedule.

3. Testing this PR schedule to see if the same effect occurs when reinforced by several teachers or a team of teachers.

4. Utilizing different groups to test the effects of a 75% or 50% PR schedule under similar conditions to see if a particular frequency of reinforcement maintains a greater response of acceptable written laboratory reports from students.

5. Testing the effects of PR with a similar group, but using a dependent variable which permits more rigorous controls than those used in this study.**

**For example, one may have students answer four short essay questions in class. Upon completion of the four questions the students would bring their papers to the teacher. He would spin a pointer on a numbered disc and grade either one, two, three, or all (25, 50, 75, or 100%) of the paragraphs.

There is a need to relate the vast amount of experimental psychological research to operational classroom situations, if practical value is to be gained from them by professional educators. This study, with its indicated limitations, has demonstrated the possibilities of quasi-controlled experiments in the classroom. From the areas for further study which have been discussed, it is evident that many aspects of the application of the principle of PR schedules to actual complex classroom learning tasks remain to be tested in future studies.

Synopsis

The hypothesis tested was that there would be no difference in the number of acceptable laboratory reports submitted by students in a ninth-grade science course under a schedule of continuous reinforcement (CR) where the teacher graded every report, as compared to the number submitted under a 25% variable-ratio partial reinforcement (PR) schedule where the teacher graded only one out of every four reports submitted by students. A 2 x 2 quasi-experimental design was used with two groups of 48 ninth-grade students during an 18-week period. Results indicated no significant differences between the two groups, which agrees with earlier findings; but no previous research had applied a PR schedule to complex student behavior in an actual secondary school classroom environment. The implications for classroom procedures were discussed.

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30. Ref. 4, op. cit.

TABLE I

STUDENT RESPONSES

Group	Acquisition period response	Reinforcement schedule	Submitted responses[a]	Non-responses	X^{2}[b]
		Phase I			
A	100%	CR	72	0	0.0000*
B		PR	68	0	
A	Less than 100%	CR	26	2	0.0914**
B		PR	19	1	
		Phase II			
A	100%	PR	68	4	0.0061***
B		CR	65	3	
A	Less than 100%	PR	23	5	0.0163****
B		CR	19	1	

[a]Each S x 4 = total no. of possible submitted responses.

[b]d.f. = 1

*p. $\angle$1.00

**p. $\angle$.80

***p. $\angle$.95

****p. $\angle$.90